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13. ABSTRACT *(Maximum 200 words)*

The Assistant Secretary of Defense (Force Management Policy) reissued Department of Defense Instruction (DoDI) 1308.3, DoD Physical Fitness and Body Fat Programs Procedures in November 2002. To bring Army Regulation (AR) 600-9, The Army Weight Control Program, into compliance with DoDI 1308.3, female screening weight-for-height tables must be increased and male and female DoD body fat equations to measure percent body fat adopted. Male screening weights will not change as they meet DoDI 1308.3 guidance. Circumference sites to measure percent body fat would change from the neck, forearm, wrist, and hips to the neck, abdomen I (waist), and hips for females. In contrast, circumference sites for males would remain the same (neck and abdomen II, at the level of the umbilicus). The U.S. Army Research Institute of Environmental Medicine (USARIEM) was asked to collect height, weight, and circumference measurements of active duty Soldiers to assess the impact of proposed changes on compliance with AR 600-9. The aim of the study was to evaluate the impact of increasing female screening weights and adopting the DoD male and female body fat equations on Soldier compliance with AR 600-9. Data were analyzed from 2,778 active duty Soldiers (1,521 males and 1,257 females) stationed at Fort Bragg, NC, Fort Leonard Wood, MO, and Fort Jackson, SC. Results suggest that changes required to AR 600-9 to comply with DoDI 1308.3 may have the following impact on the Army active force: overall, the proportion of noncompliant males and females would remain the same; fewer body fat compliant females would require a body fat measurement; and more Soldiers with unhealthy body fat depots about the abdomen/waist would be identified as being noncompliant with AR 600-9. Changes to AR 600-9 would align body fat measurements with health goals of the Army Weight Control Program.

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RATIONALE AND EVIDENCE SUPPORTING CHANGES TO THE ARMY WEIGHT CONTROL PROGRAM

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DISCLAIMER STATEMENTS

The views, opinions and/or findings contained in this publication are those of the authors and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, Use of Volunteers as Subjects of Research, and the research was conducted in adherence with the provisions of 42 Code of Federal Regulations (CFR) Part 46 and 32 CFR Part 219.

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ACRONYMS/ABBREVIATIONS

Abdomen I	Circumference measurement at the natural waist (smallest circumference midway between the xiphoid process of the sternum and the umbilicus anteriorly, and between the lowest lateral portion of the rib cage and the iliac crest laterally) to measure percent body fat in female Soldiers
Abdomen II	Circumference measurement at the level of the iliac crests (laterally) and of the umbilicus (anteriorly) to measure percent body fat in male Soldiers
AR	Army Regulation
BMI	Body mass index (kg/m^2)
CFR	Code of Federal Regulations
DoD	Department of Defense
DoDI	Department of Defense Instruction
IAW	In accordance with
USARIEM	U.S. Army Research Institute of Environmental Medicine

EXECUTIVE SUMMARY

The Assistant Secretary of Defense (Force Management Policy) reissued Department of Defense Instruction (DoDI) 1308.3, DoD Physical Fitness and Body Fat Programs Procedures in November 2002. To bring Army Regulation (AR) 600-9, The Army Weight Control Program, into compliance with DoDI 1308.3, female screening weight-for-height tables must be increased and male and female DoD body fat equations to measure percent body fat adopted. Male screening weights will not change as they meet DoDI 1308.3 guidance. Circumference sites to measure percent body fat would change from the neck, forearm, wrist, and hips to the neck, abdomen I (waist), and hips for females. In contrast, circumference sites for males would remain the same (neck and abdomen II, at the level of the umbilicus). The U.S. Army Research Institute of Environmental Medicine (USARIEM) was asked to collect height, weight, and circumference measurements of active duty Soldiers to assess the impact of proposed changes on compliance with AR 600-9.

The aim of the study was to evaluate the impact of increasing female screening weights and adopting the DoD male and female body fat equations on Soldier compliance with AR 600-9. Data were analyzed from 2,778 active duty Soldiers (1,521 males and 1,257 females) stationed at Fort Bragg, NC, Fort Leonard Wood, MO, and Fort Jackson, SC.

Results suggest that required changes to AR 600-9 to comply with DoDI 1308.3 may have the following impact on the Army active force: overall, the proportion of noncompliant males and females would remain the same; fewer body fat compliant females would require a body fat measurement; and more Soldiers with unhealthy body fat depots about the abdomen/waist would be identified as being noncompliant with the proposed AR 600-9. Changes to AR 600-9 align body fat measurements with health goals of the Army Weight Control Program.

INTRODUCTION

The Assistant Secretary of Defense (Force Management Policy) reissued DoDI 1308.3, DoD Physical Fitness and Body Fat Programs Procedures, in November, 2002 (5). The revised DoDI prescribes new policies and procedures governing military weight management programs. Specifically, the Services must 1) establish screening weights that fall within a range equivalent to a body mass index (BMI) of 25.0 – 27.5 kg/m^2, regardless of gender (Table A-1); 2) adopt the same circumference-based DoD body fat equations (14); and 3) establish body fat standards that fall within the range of 18 – 26 percent body fat for males and between 26 – 36 percent body fat for females.

Screening weights are the first level of assessment for the Army Weight Control Program; Soldiers exceeding their screening weight must have their body fat measured. Body fat, and not body weight, is the standard by which Soldiers are placed on or removed from the Army Weight Control Program (6). To guard against exceeding their screening weight, Soldiers are encouraged to select a personal weight goal that is within a 5% zone below their screening weight (6). DoDI 1308.3 establishes, for the first time, screening weights based on body mass index (BMI) norms established by an expert panel (21; Table 1). Body mass index, the ratio of body weight to height, is used to classify the weight status of individuals. DoDI 1308.3 prescribes screening weights that equate to a BMI range of 25.0 to 27.5 kg/m^2. U.S. Army screening weights, when converted to BMI, may not be more stringent than 25.0 kg/m^2 or greater than 27.5 kg/m^2, regardless of sex (Table A-1).

Table 1. Weight classification by NHLBI body mass index cut offs.

Weight Status	Body Mass Index[1]	Obesity Class
	kg/m^2	
Underweight	< 18.5	
Normal	18.5 – 24.9	
Overweight	25.0 – 29.9	
Obesity	30.0 – 34.9	I
	35.0 – 39.9	II
Extreme obesity	≥ 40	III

NHLBI, National Heart, Lung, and Blood Institute.
[1]Calculated as [weight (kg) / height squared (m^2)] or as [weight (lbs) / height (inches)^2] x 704.5
SOURCE: Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults (21).

Army screening weights are incrementally adjusted for age groupings of 17 – 20, 21 – 27, 28 – 39, and 40 years of age and over (6). Male screening weights, when converted to BMI, comply with DoDI 1308.3, thus no change is required (Table 2 and Table B-1). With the exception of females ages 40 years and older, female screening weights, when converted to BMI, fall below the DoDI lower BMI limit of 25.0 kg/m^2 (Table 2 and B-2) and must be increased to comply with the DoDI. The proposed female screening weights were based on the notion that most overfat females would be identified at a weight equivalent to a BMI of 25.0 kg/m^2 and that the proposed screening weights had to be incrementally adjusted (increased) to account for AR 600-9 age

groups (i.e., 17 – 20, 21 – 27, 28 – 39, and 40 years of age and over). Because there is no comparable BMI between males and females that adequately detects overfat Soldiers, an arbitrarily higher BMI, above which identified the majority of overfat female Soldiers, was set at 26.0 kg/m^2, therefore, the target BMI range for the proposed female screening weights was 25.0 to 26.0 kg/m^2 with evenly spaced BMI increments for AR 600-9 age groups (K.E. Friedl personal communication, July 2004). The proposed female screening weights, when converted to BMI, range from 24.9 to 26.1 kg/m^2 (Table B-2), and meet the range prescribed in DoDI 1308. The minor deviations (e.g., 24.9 vs. 25.0 kg/m^2) reflect integer rounding differences in the tables. The incremental increases in screening weights for each age group amount to an allowance of 2.3 to 4.1 kg (5 to 9 lbs) from the youngest to the oldest age group for females; currently, the allowance is 4.5 to 8.6 kg (10 to 19 lbs). Males, on the other hand, are given an incremental weight allowance of 4.1 to 7.3 kg (9 lbs to 16 lbs).

Table 2. AR 600-9 screening weights converted to body mass index.

Age Group	Male	Female
	kg/m^2	
17 – 20 years	25.7 – 25.9	22.7 – 23.1
21 – 27 years	26.4 – 26.6	23.3 – 23.7
28 – 39 years	27.1 – 27.3	24.0 – 24.4
≥ 40 years	27.5 – 27.6	24.7 – 25.1

NOTE: DoDI 1308.3 prescribes a BMI range of 25.0 – 27.5 kg/m^2, regardless of sex. The range represents the lowest and highest BMI from each age group.

Body fat standards were first established with the 1983 publication of AR 600-9. Male body fat standards have since remained unchanged. However, female body fat standards were increased 2% for each age group in 1991 (8; 10). AR 600-9 body fat standards fall within the ranges prescribed in DoDI 1308.3 and need not be adjusted (Table 3).

Table 3. AR 600-9 body fat standards.

Age group	Males	Females
	percent body fat	
17 – 20 (yrs)	20	30
21 – 27 (yrs	22	32
28 – 39 (yrs)	24	34
40 + (yrs)	26	36

NOTE: DoDI 1308.3 prescribes standards in the range of 18 – 26 percent body fat for males and 26 – 36 percent body fat for females.
SOURCE: AR 600-9, The Army Weight Control Program (6).

Equations to measure body fat (Table 4) are incorporated into AR 600-9 as factor tables to calculate percent body fat. Current AR 600-9 factor tables are based on Army developed equations (26). In order to "avoid unnecessary confusion and perceptions of unfairness between Services," DoDI 1308.3 requires the Services to use the same body fat equations (5). Thus, factor tables in AR 600-9 would need to be changed to the tables specified in DoDI 1308.3 (14). Circumference sites to measure percent body fat for males (neck and abdomen II, at the level of the umbilicus) would not change.

However, circumference sites for females would change from the neck, forearm, wrist, and hips to neck, abdomen I (waist), at the level of the narrowest circumference, and hips.

The purpose of the study was to evaluate how Soldier compliance with AR 600-9 would be affected if proposed changes to bring AR 600-9 into compliance with DoDI 1308.3 were implemented (increase female screening weights and adopt the DoD male and female body fat equations). This was a follow-on effort that aimed to increase the sample size of an existing database (16) and, importantly, to over-sample female volunteers in order to ensure a robust representative sample to assess the impact of proposed changes on compliance with AR 600-9 in female Soldiers. Our specific objectives were the following:

1. Evaluate how retaining current screening weights and adopting the male DoD body fat equation affects compliance of male Soldiers with AR 600-9.

2. Evaluate how increasing screening weights and adopting the female DoD body fat equation affects compliance of female Soldiers with AR 600-9.

3. Determine whether proposed changes to AR 600-9 support health objectives of AR 600-9.

Table 4. Military circumference-based body fat equations.

MEN[1]
U.S. ARMY[2]
%BF = (76.46 x $\log_{10}$ [abdomen II – neck]) – (68.68 x $\log_{10}$ [height]) + 46.89
r = 0.82, SEE = 4.02
DoD[3]
%BF = (86.010 x $\log_{10}$[abdomen II – neck]) – (70.041 x $\log_{10}$[height]) + 36.76
r = 0.90, SEE = 3.52
WOMEN[1]
U.S. ARMY[2]
%BF = (105.3 x $\log_{10}$ [weight]) – (0.51 x wrist) – (1.35 x neck) – (3.99 x forearm) + (0.44 x hip) – (1.31 x height) – 71.76
r = 0.82, SEE = 3.60
DoD[3]
%BF = (163.205 x $\log_{10}$ [abdomen I + hip – neck]) – (97.684 x $\log_{10}$ [height]) – 78.387
r = 0.86, SEE = 3.61

Refer to text for circumference site locations. %BF, percent body fat; SEE, standard error of the estimate.
[1]Equation as adapted in AR 600-9 but different from the original research study derivation.
[2]Measurements are in inches and weight in pounds (16; 26)
[3]Reformulated Navy equation based on U.S. Navy equations (26; 12; 13); measurements are in inches.

METHODS

VOLUNTEERS

Data were collected at two different times: Soldiers assigned to Fort Bragg, NC, Fort Leonard Wood, MO, and Fort Jackson, SC, in October and November 2000, and Soldiers assigned to Fort Bragg, NC, in October and November 2002. The study protocol was given exempt status as a routine epidemiological survey in accordance with 45 CFR 46.101(b), 32 CFR 219.101(b), and AR 70-25, Use of Human Subjects in Research, Appendix F (7), because data were collected without personal identifiers (name, social security number, or unit of assignment). The institutional review boards at USARIEM and Womack Army Medical Center, Fort Bragg, NC, and the Clinical Investigations Review Board, Fort Sam Houston, TX, waived the requirement for obtaining signed informed consent. Volunteers were informed of the study rationale, objectives, and requirements for study participation. Study participation was not mandatory. Agreeing to participate in the study was understood as providing informed consent. To minimize interference with training and duty schedules, data collection coincided with random drug screening (2000) and daily morning unit physical training (2002).

A total of 2,841 volunteers (1,395 volunteers in 2000 and 1,446 in 2002) participated in the study. Incomplete data (missing age, height, weight, gender, or circumferences), or if a female volunteer reported being pregnant excluded 63 volunteers (6 males, 56 females, and 1 of unknown gender). Of those with incomplete data, 8 were from 2000 (4 males and 4 females) and 55 from 2002 (2 males, 52 females, and 1 of unknown gender). Complete data from 2,778 active duty Soldiers (1,521 males and 1,257 females), after combining data from 2000 (n=1387 volunteers) and 2002 (n=1391 volunteers), were used in the analysis.

We applied a different strategy than Leu and Friedl (16) to categorize volunteers as meeting or exceeding their screening weight and body fat standard. Specifically, we included data from 1039 males and 348 females collected in 2000 in the analysis; a different sample size than that reported by Leu and Friedl, 1043 males and 347 females (16). Four males were omitted from the current analysis because of incomplete data, while one previously excluded female volunteer was included in the current analysis. Volunteers exceeding their screening weight by less than 0.5 lbs were categorized as meeting their screening weight; these same volunteers were categorized as exceeding their screening weight by Leu and Friedl. Our strategy is consistent with guidance in DoDI 1308.3 and in the current and proposed AR 600-9 to round body weight down to the nearest whole pound if the fraction is less than 0.5 lbs. Likewise, volunteers exceeding their body fat standard by less than 0.5% were categorized as meeting their percent body fat standard, as the DoD factor tables show percent body fat values in whole numbers; conversely, Leu and Friedl considered these volunteers as exceeding their body fat standard. The data from Leu and Friedl, included in this analysis, was subjected to the same rounding strategy for body weight as described above.

HEIGHT AND BODY WEIGHT

Freestanding stadiometers and calibrated battery-operated scales were used to measure volunteer height and weight, respectively. Height was measured in stocking feet. Volunteers were weighed in their Army physical fitness uniform (shorts, t-shirt, and socks). No correction was made for clothing. Body mass index was calculated from measured height and weight as weight (kg)/height $(m)^2$. To determine compliance of volunteers with AR 600-9, rounding of weight and height was made in accordance with AR 600-9 and DoDI 1308.3 (5; 6).

ANTHROPOMETRIC MEASUREMENTS

Trained anthropometrists measured body circumferences using a flexible anthropometric tape measure following procedures in AR 600-9 and DoDI 1308.3 (5; 6). Volunteers stood while having their circumferences measured. The two circumference sites for males were the neck (just inferior to the larynx) and abdomen II (at the level of the iliac crests [laterally] and of the umbilicus [anteriorly]). Female volunteers had five circumference sites measured: the neck (just inferior to the larynx), forearm (maximal girth), wrist (minimal girth just distal to the styloid process of the radius and the ulna), abdomen I (natural waist at the smallest circumference midway between the xiphoid process of the sternum and the umbilicus anteriorly, and between the lowest lateral portion of the rib cage and the iliac crest laterally), and hip (point of greatest protrusion of the gluteal muscles posteriorly). Two measurements were taken at each site. If there was a difference of more than 0.6 cm (0.25 inches) between the first and second measurements, a third or fourth measurement was taken (6). The mean of the two measurements was used in subsequent calculation of percent body fat using the Army and DoD body fat equations (Table 4). No rounding of measurements was made to calculate percent body fat. However, percent body fat was rounded to the nearest whole percent when determining compliance with AR 600-9.

DEMOGRAPHIC QUESTIONNAIRE

Volunteers were asked to report their age, gender, ethnic affiliation, military occupation specialty, and rank (Appendix C). They did not report personal identifiers (name, social security number, or unit of assignment).

DATA ANALYSIS

Descriptive statistics and frequencies were computed. Differences between data collected in 2000 and 2002 and between males and females were analyzed using Student's independent *t* test. In accordance with AR 600-9, compliance was based on meeting or exceeding age and gender specific body fat standards. Therefore, volunteers compliant with AR 600-9 met their body fat standard and either met or exceeded their screening weight (6). Conversely, noncompliant volunteers exceeded their body fat standard and met or exceeded their screening weight (6). Relationships between Army and DoD body fat equations were explored using Pearson's product-moment coefficient (r). The Pearson χ^2 and McNemar χ^2 (for paired data) were used to

evaluate 2 x 2 contingency tables for compliance between current and proposed versions of AR 600-9 by gender. 2 x 4 contingency tables assessing compliance with AR 600-9 by age group (17-20, 21-27, 28-39, and ≥40 years old) were evaluated using Pearson's χ^2. The Kappa statistic was calculated to correct for chance agreement in compliance between the current and proposed AR 600-9 (23). Bland-Altman plots were used to evaluate the level of agreement in predicting percent body fat between the two equations (2; 3). Analyses were performed using SPSS 11.5 for Windows (SPSS Inc., Chicago, IL). Data are reported as means ± SD. Statistical significance was taken to be $p \leq 0.05$.

RESULTS

VOLUNTEER CHARACTERISTICS

Comparisons of volunteer characteristics between the two data collection periods (2000 and 2002) are at Table 5 and 6. Volunteer characteristics were not different between the two data collection periods for males (Table 5). In contrast, hip and abdominal (natural waist) circumferences were larger in the 2002 series for the female volunteers as was percent body fat calculated by the Army and DoD equations (p=0.0005, Table 6). On average, female Soldiers were shorter, weighed less, had a lower BMI, and higher percent body fat (measured by the Army or DoD equations) than male Soldiers (p=0.0005). The range of BMI for the sample was wide, 14.2 to 40.6 kg/m^2 and 17.3 to 43.0 kg/m^2 for males and females, respectively (Figure 1). Of the sample, 60.1% (n=914) of the males and 40.6% (n=510) of the females were classified as overweight or obese (BMI ≥ 25.0 kg/m^2). More males, 14.1% (n=215), than females, 6.1% (n=77), were classified as obese (BMI ≥ 30.0 kg/m^2).

Table 5. Characteristics of male volunteers from two data collection periods.

	Data collection period			
	2000	2002	Total	p[1]
n	1039	482	1521	
Age (years)	27.6 ± 7.3	27.2 ± 7.0	27.5 ± 7.2	0.32
Height (cm)	176.6 ± 6.7	176.2 ± 7.3	176.5 ± 6.9	0.29
Weight (kg)	81.3 ± 12.1	81.4 ± 12.3	81.3 ± 12.2	0.84
Body mass index (kg/m^2)	26.0 ± 3.3	26.2 ± 3.6	26.1 ± 3.4	0.31
Neck circumference (cm)	38.4 ± 2.3	38.4 ± 2.3	38.4 ± 2.3	0.77
Abdomen II circumference (cm)	85.9 ± 8.6	86.7 ± 9.0	86.1 ± 8.8	0.09
Body fat (USA, %)	17.2 ± 5.1	17.8 ± 5.3	17.4 ± 5.2	0.04
Body fat (DoD, %)	16.7 ± 5.8	17.3 ± 6.0	16.9 ± 5.9	0.04

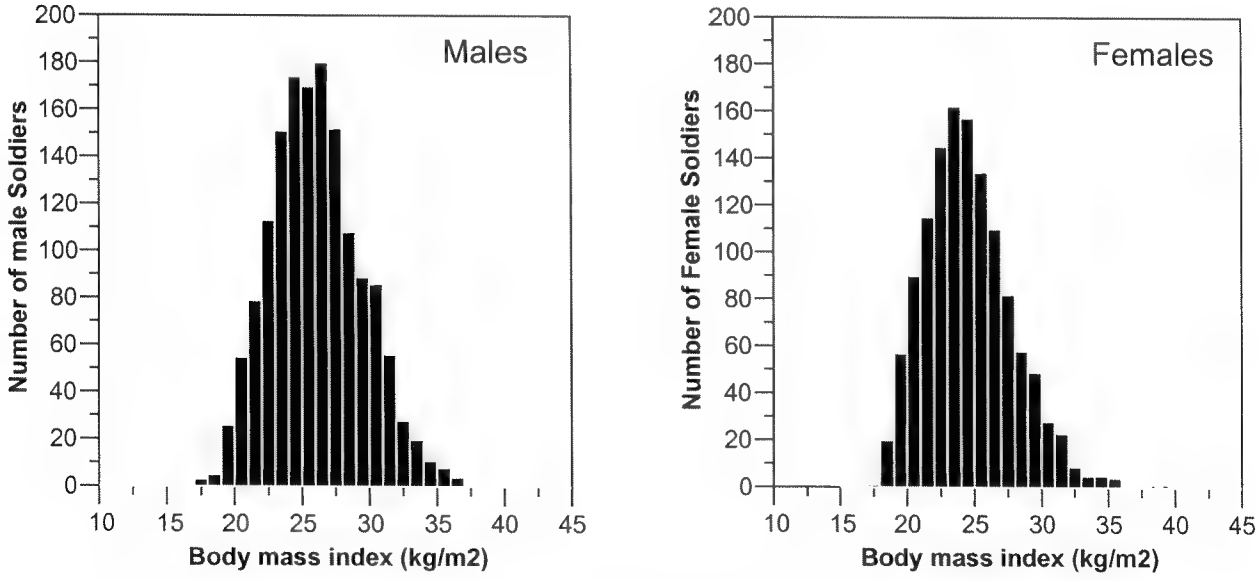
USA, U.S. Army body fat equation; DoD, DoD body fat equation. Refer to text for anatomical landmarks for circumference sites. All comparisons were not significant.
[1] Significance set at p=0.006, with Bonferroni correction for multiple comparisons (0.05/8).

Table 6. Characteristics of female volunteers from two data collection periods.

	Data collection period			
	2000	2002	Total	p^1
n	348	909	1257	
Age (years)	27.3 ± 6.9	26.2 ± 6.5	26.5 ± 6.6	0.01
Height (cm)	163.5 ± 6.3	163.1 ± 6.2	163.3 ± 6.2	0.31
Weight (kg)	65.6 ± 10.1	65.6 ± 10.2	65.6 ± 10.2	0.96
Body mass index (kg/m^2)	24.5 ± 3.2	24.6 ± 3.3	24.6 ± 3.3	0.53
Neck circumference (cm)	32.5 ± 1.9	32.4 ± 1.9	32.5 ± 1.9	0.53
Forearm circumference (cm)	24.1 ± 1.9	24.3 ± 1.8	24.2 ± 1.8	0.06
Wrist circumference (cm)	15.1 ± 1.1	14.9 ± 1.0	15.0 ± 1.0	0.02
Abdomen I circumference (cm)	73.7 ± 7.7	76.0 ± 8.7	75.4 ± 8.5	0.0005[2]
Hip circumference (cm)	91.6 ± 8.8	98.6 ± 7.9	96.7 ± 8.7	0.0005[2]
Body fat (USA, %)	28.6 ± 4.8	29.7 ± 5.0	29.4 ± 4.9	0.0005[2]
Body fat (DoD, %)	25.0 ± 7.4	30.0 ± 6.7	28.6 ± 7.3	0.0005[2]

USA, U.S. Army body fat equation; DoD, DoD body fat equation. Refer to text for anatomical landmarks for circumference sites.
[1]Significance set at p=0.0045, with Bonferroni correction for multiple comparisons (0.05/8).
[2]Data from 2002 sample significantly different from 2000 sample, p<0.0005.

Figure 1. Distribution of volunteers by body mass index.
Each bar represents 1 BMI unit (kg/m^2).



Demographics of volunteers in the 2002 sample are in Table 7. Volunteers in the 2000 sample did not report ethnic affiliation, military occupation specialty, or rank because it was irrelevant to planned analyses, and so a comparison of these characteristics between the two samples can not be made. The majority of male volunteers in the 2002 sample was Caucasian (52.7%), had a combat service support military occupation specialty (80.5%), and was enlisted (92.7%); these characteristics were similar in the female volunteers, except the majority was African American

(41.0%). As of September 15, 2003, 40.7% of the Army total active force reported belonging to a minority race with fewer males than females reported belonging to a minority race, 37.5% vs. 58.6%, respectively (Army G-1, Office of Army Demographics). A similar trend was observed in the 2002 sample, with 47.3% of the males and 66.3% of the females reporting they belonged to a minority race. The 2002 sample also had a higher representation of enlisted grades than that of the total active force: 91.6% vs. 83.8%, respectively (Army G-1, Office of Army Demographics).

Table 7. 2002 sample volunteer demographics.

	Males	Females
N	482	909
Ethnic affiliation[1]		
Caucasian	253 (52.7%)	305 (33.7%)
African American	140 (29.2%)	371 (41.0%)
Hispanic	53 (11.0%)	137 (15.2%)
Native American / Alaskan Native	4 (0.8%)	20 (2.2%)
Asian / Pacific Islander	12 (2.5%)	28 (3.1%)
Other[2]	18 (3.8%)	43 (4.8%)
Military occupation specialty[3]		
Combat arms	15 (3.1%)	10 (1.1%)
Combat service support	384 (80.5%)	700 (78.0%)
Health services	78 (16.4%)	188 (20.9%)
Rank[4]		
Enlisted	442 (92.7%)	826 (91.6%)
Warrant Officer	5 (1.0%)	12 (1.3%)
Commissioned Officer	30 (6.3%)	65 (7.2%)

[1]Data missing from 2 males and 5 females.
[2]Reported as multi-ethnic affiliation.
[3]Unable to confirm valid military occupation specialty of 5 males and 11 females.
[4]Data missing from 5 males and 7 females.

STATUS WITH THE CURRENT AR 600-9

Over one third (38.1%, n=579) of the male volunteers and over half (54.6%, n=686) of the female volunteers exceeded their screening weight and would therefore have been required to have their body fat measured to determine their compliance with AR 600-9 (Table 8). Of all volunteers, 10.5% (n=160) of the males and 22.4% (n=281) of the females exceeded their screening weight and body fat standard, thereby meeting criteria for enrollment in the Army Weight Control Program. The proportion of volunteers that exceeded their screening weight and who were also identified as exceeding their body fat standard was 27.6% and 41.0% of males and females, respectively. Volunteers meeting their screening weight and exceeding their body fat standard represented only 1.0% of the male and female volunteers; although technically noncompliant, these volunteers would not have gotten their body fat measured unless directed to do so by their supervisor because of a poor military appearance. More males than females were in compliance with AR 600-9, 88.5% (n=1346) vs. 76.7%

(n=964), respectively (χ^2=68.452, p=0.0005, Table 8). Differences in compliance with AR 600-9 across age groups were significant in males (χ^2=11.441, p=0.01, Table 9) but not females (χ^2=7.538, p=not significant, Table 9). Male volunteers ages 17 – 20 and ≥ 40 years old were more likely to be compliant with AR 600-9.

Table 8. Compliance with current AR 600-9 screening weights and body fat standards.

	Male				**Female**		
	Screening weight				Screening weight		
%BF	Meet	Exceed	Total	%BF	Meet	Exceed	Total
Meet	927 (60.9%)	419 (27.5%)	1346[1] (88.5%)	Meet	559 (44.5%)	405 (32.2%)	964 (76.7%)
Exceed	15 (1.0%)	160 (10.5%)	175 (11.5%)	Exceed	12 (1.0%)	281 (22.4%)	293 (23.3%)
Total	942 (61.9%)	579 (38.1%)	1521	Total	571 (45.4%)	686 (54.6%)	1257

Percent of total sample are given in parentheses. %BF, percent body fat (by U.S. Army equation, (26).
[1]More males than females were in compliance with AR 600-9, Pearson χ^2=68.452, p=0.0005.

Table 9. Compliance with current AR 600-9 by age group.

	Males[1]					**Females**[2]				
	AR 600-9 age groups					AR 600-9 age groups				
	17-20	21-27	28-39	≥40	Total	17-20	21-27	28-39	≥40	Total
Meet	230 (92.4)	550 (85.9)	465 (88.6)	101 (94.4)	1346	167 (72.9)	430 (74.9)	320 (80.4)	47 (83.9)	964
Exceed	19 (7.6)	90 (14.1)	60 (11.4)	6 (5.6)	175	62 (27.1)	144 (25.1)	78 (19.6)	9 (16.1)	293
Total	249	640	525	107	1521	229	574	398	56	1257

Percent of column totals are given in parentheses. Body fat measured by U.S. Army equation.
[1]Significant differences in compliance status across AR 600-9 age groups, χ^2=11.441, p=0.01.
[2]Differences in compliance status across AR 600-9 age groups are nonsignificant, χ^2=7.538, p =not significant).

The male and female volunteers that exceeded their screening weight did so, on average, by 8.4±6.5 kg (18.4±14.4 lbs) and 8.2 ± 6.7 kg (18.1±14.8 lbs), respectively. The greatest excess weight above a screening weight was 38.4 kg (84.4lbs) and 51.7 kg (113.8 lbs) for male and female volunteers, respectively (Figure 2). Conversely, male and female volunteers that met their screening weight did so, on average, by -8.6±6.2 kg (-19.0±13.5 lbs) and by -5.2±3.9 kg (-11.4±8.6 lbs), respectively. The most a male or female volunteer met their screening weight was by -40.7 kg (89.6 lbs) and by -18.5 kg (-40.6 lbs), respectively. Only 1.4% (n=22) of male and 1.7% (n=21) of female volunteers had body weights that exactly equaled their screening weight. Differences in compliance with screening weights across AR 600-9 age groups were significant in males (χ^2=23.952, p=0.0005, Table 10) but not females (χ^2=2.917, p =not significant, Table 10). Male volunteers ages 17 – 20 and over 40 years old were more compliant with their screening weight than 21 – 39 year old volunteers.

Figure 2. Proximity of volunteers to their screening weight-for-height. Each bar represents 2.5 kg.

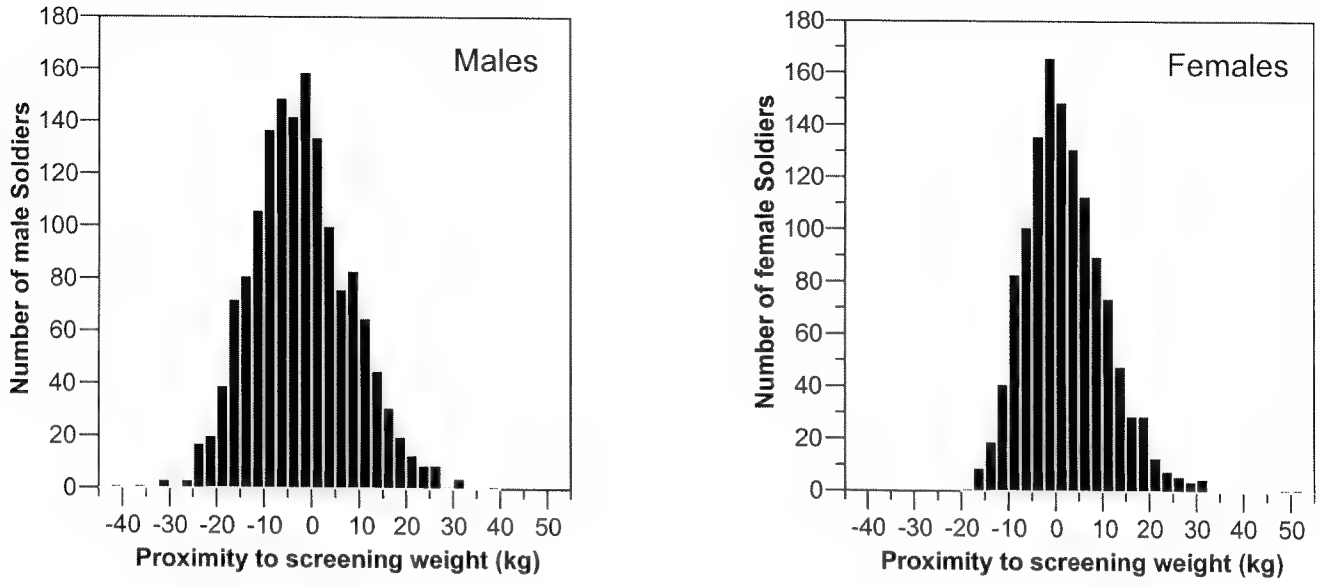


Table 10. Compliance with current screening weights by age group.

	Male[1] AR 600-9 age groups					**Female**[2] AR 600-9 age groups				
	17-20	21-27	28-39	≥40	Total	17-20	21-27	28-39	≥40	Total
Meet	182 (73.1)	406 (63.4)	290 (55.2)	64 (59.8)	942	108 (47.2)	267 (46.5)	176 (44.2)	20 (35.7)	571
Exceed	67 (26.9)	234 (36.6)	235 (44.8)	43 (40.2)	579	121 (52.8)	307 (53.5)	222 (55.8)	36 (64.3)	686
Total	249	640	525	107	1521	229	574	398	56	1257

Percent of column totals are given in parentheses.
[1]Significant differences in compliance status across AR 600-9 age groups, χ^2=23.952, p=0.0005.
[2]Differences in compliance status across AR 600-9 age groups are nonsignificant, χ^2=2.917, p=not significant.

AR 600-9 body fat standards were met by 88.5% (n=1346) of male and 76.7% (964) of female volunteers (Table 8). The range of measured percent body fat was wide for both groups, ranging from 0.9% to 32.1 percent body fat for males and from 16.7% to 47.5 percent body fat for females (Figure 3). Three male volunteers had percent body fat measurements below the essential level of 3.0 percent body fat (17). Although physiologically implausible, the data from these male volunteers remained in the analysis as their compliance with AR 600-9 was correctly documented. On average, overfat males exceeded their body fat standard by 2.3 ± 1.6 percent body fat, with the most excess body fat above their standard being 10.1 percent body fat (Figure 4). Similarly, overfat female volunteers exceeded their body fat standard by 3.3 ± 2.6 percent body fat, with the most excess body fat above their body fat standard being 15.5 percent body fat (Figure 4). Male and female volunteers that met their body fat standard did so by -6.2 ± 4.3 percent body fat and by -4.9 ± 3.6 percent body fat, with the largest difference being -21.1% and -16.3 percent body fat below their standard, respectively (Figure 4). Differences in compliance with body fat standards across AR

600-9 age groups were significant in males (χ^2=11.441, p=0.01, Table 11) but not females, although the differences were approaching significance (χ^2=7.538, p=0.057, Table 11). Male volunteers ages 17 – 20 and 40 years old and older were more likely to meet their body fat standard.

Figure 3. Distribution of volunteers by percent body fat (Army equations). Each bar represents 2.0 percent body fat.

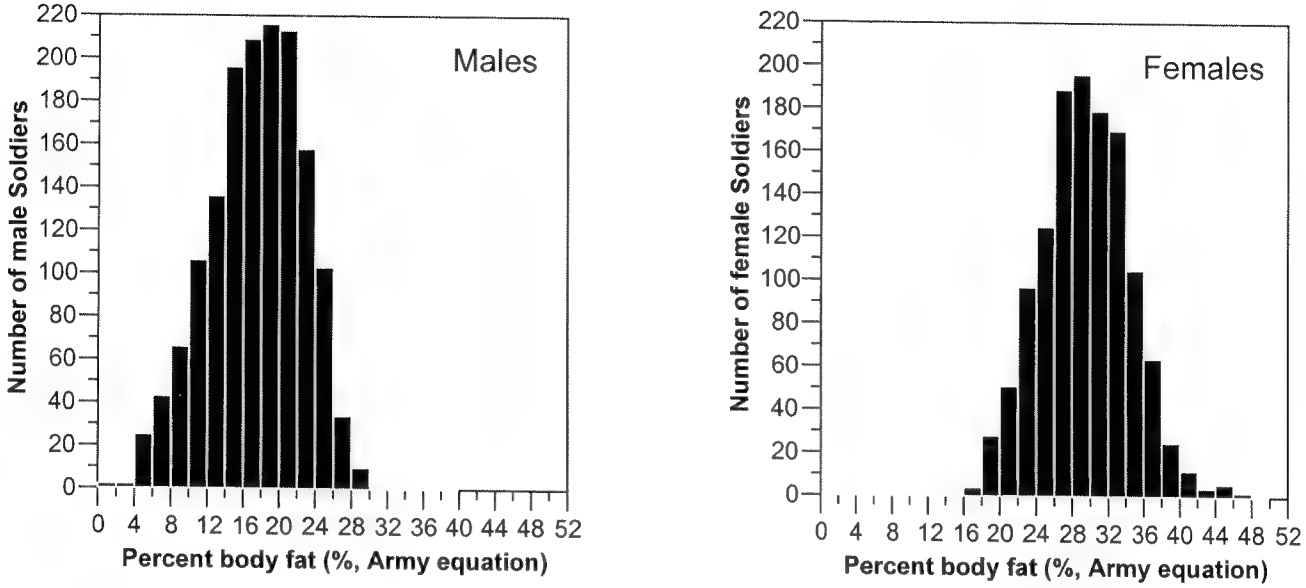


Figure 4. Proximity of volunteers to their body fat standard (Army equations). Each bar represents 2% body fat.

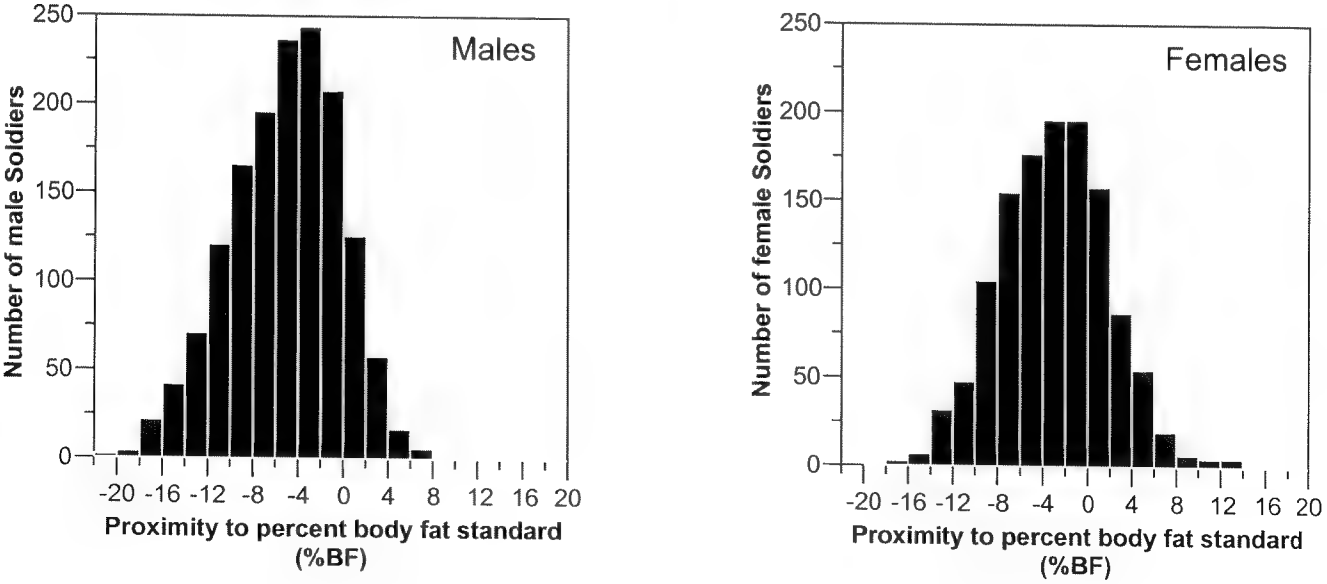


Table 11. Compliance with body fat standards by age group (Army equations).

	Male[1] AR 600-9 age groups					Female[2] AR 600-9 age groups				
	17-20	21-27	28-39	≥40	Total	17-20	21-27	28-39	≥40	Total
Meet	230 (92.4)	550 (85.9)	465 (88.6)	101 (94.4)	1346	167 (72.9)	430 (74.9)	320 (80.4)	47 (83.9)	964
Exceed	19 (7.6)	90 (14.1)	60 (11.4)	6 (5.6)	175	62 (27.1)	144 (25.1)	78 (19.6)	9 (16.1)	293
Total	249	640	525	107	1521	229	574	398	56	1257

Percent of column totals in parentheses.
[1]Significant differences in compliance status across AR 600-9 age groups, χ^2=11.441, p=0.01.
[2]Differences in compliance status across AR 600-9 age groups are not significant, χ^2=7.538, p=0.057.

STATUS WITH PROPOSED AR 600-9

Increasing female screening weights reduced the proportion of females that exceeded their screening weight, and thereby reduced the number of females who would have been required to have their body fat measured by 20.2% (from 54.6% to 34.4%), yet the proportion of volunteers that were noncompliant with AR 600-9, i.e., exceeding their screening weight and body fat standard, remained unchanged (22.6% vs. 22.4%, Table 12). More males than females complied with the proposed AR 600-9, 87.9%, (n=1337) vs. 73.3% (n=921), respectively (χ^2=96.858, p=0.0005, Table 12). Similarly, there was a minimal change in the proportion of males that exceeded their screening weight and body fat standard, from 10.5% to 11.2%, when comparing the current and proposed AR 600-9; of those exceeding their screening weight, 29.4% (n=170) and 65.7% (n=284) of the male and female volunteers, respectively, exceeded their body fat standard. Volunteers meeting their screening weight and exceeding their body fat standard increased in the female volunteers (from 1.0% to 4.1%), but remained at 1.0% for the male volunteers. Differences in compliance with the proposed AR 600-9 were significant for males across age groups (χ^2=14.403, p=0.002), but not for females (χ^2=4.721, p=not significant, Table 13). Male volunteers ages 17 – 20 and 40 years old and older were more likely to meet the proposed AR 600-9.

The coefficient of agreement in compliance status between the current and proposed AR 600-9 was 99.1% (1508 of 1521 volunteers) for males and 85.6% (1076 of 1257 volunteers) for females (Tables D1 and D2, respectively). Reliability in compliance status between the current and proposed AR 600-9, measured using the kappa statistic, was higher for males than females, 0.96 vs. 0.62, respectively. For males, 0.85% (n=13) changed their status (e.g., from $meet_{current}$ to $exceed_{proposed}$ and from $exceed_{current}$ to $meet_{proposed}$) as a result of the change in body fat equations. Although small, the change in compliance status was significantly greater for males changing their compliance status from $meet_{current}$ to $exceed_{proposed}$ than from $exceed_{current}$ to $meet_{proposed}$ (0.7% vs. 0.1%, McNemar χ^2=6.231, p=0.02, Table 14). More female volunteers changed their compliance status than males, 14.4% (n=181), with significantly more changing from $meet_{current}$ to $exceed_{proposed}$ than from $exceed_{current}$ to $meet_{proposed}$ (8.9% vs. 5.5%, (McNemar χ^2=10.215, p=0.0002, Table 14). Male

volunteers whose compliance status changed to noncompliant with the proposed AR 600-9 were, on average, 11.4 kg (~25 lbs) above their screening weight and 0.8 percent body fat above their body fat standard, measured with the DoD body fat equation (Table 15); a small increase in excess body fat above their body fat standard when measured with the Army body fat equation. Female volunteers that changed their compliance status to noncompliant were, on average, 6.0 kg (~13.2 lbs) above their screening weight and were 3.4 percent body fat above their body fat standard (Table 15).

Table 12. Compliance with proposed AR 600-9 screening weights and body fat standards.

Male

%BF	Screening weight: Meet	Screening weight: Exceed	Total
Meet	928 (61.0%)	409 (26.9%)	1337[1] (87.9%)
Exceed	14 (0.9%)	170 (11.2%)	184 (12.1%)
Total	942 (61.9%)	579 (38.1%)	1521

Female

%BF	Screening weight: Meet	Screening weight: Exceed	Total
Meet	773 (61.5%)	148 (11.8%)	921 (73.3%)
Exceed	52 (4.1%)	284 (22.6%)	336 (26.7%)
Total	825 (65.6%)	432 (34.4%)	1257

Percent of total sample in parentheses. %BF, percent body fat (by DoD equation (14).
[1]More males than females were compliant with AR 600-9, χ^2=96.858, p=0.0005.

Table 13. Compliance with proposed AR 600-9 by age group.

Males[1]

	AR 600-9 age groups: 17-20	21-27	28-39	≥40	Total
Meet	232 (93.2)	548 (85.6)	456 (86.9)	101 (94.4)	1337
Exceed	17 (6.8)	92 (14.4)	69 (13.1)	6 (5.6)	184
Total	249	640	525	107	1521

Females[2]

	AR 600-9 age groups: 17-20	21-27	28-39	≥40	Total
Meet	162 (72.9)	420 (74.9)	303 (80.4)	36 (83.9)	921
Exceed	67 (27.1)	154 (25.1)	95 (19.6)	20 (16.1)	336
Total	229	574	398	56	1257

Percent of column totals are given in parentheses.
[1]Significant differences in compliance status across AR 600-9 age groups, χ^2=14.403, p=0.002.
[2]Differences in compliance status across AR 600-9 age groups are nonsignificant, χ^2=4.721, p=not significant.

Table 14. Change in compliance status with proposed changes to AR 600-9.

Males[1]

Proposed	Current AR 600-9[1]: Meet	Current AR 600-9[1]: Exceed	Total
Meet	1335 (87.8)	2 (0.1)	1337
Exceed	11 (0.7)	173 (11.4)	184
Total	1346	175	1521

Females[2]

Proposed	Current AR 600-9[2]: Meet	Current AR 600-9[2]: Exceed	Total
Meet	852 (67.8)	69 (5.5)	921
Exceed	112 (8.9)	224 (17.8)	336
Total	964	293	1257

Percent of total sample in parentheses.
[1,2]Change in compliance status (from $meet_{current}$ to $exceed_{proposed}$ > $exceed_{current}$ to $meet_{proposed}$); [1]McNemar χ^2=6.231, p=0.02; [2]McNemar χ^2=10.215, p=0.0002.

On average, female volunteers exceeded their proposed screening weight by 7.2±6.3 kg (15.9 ± 13.8 lbs), with the greatest excess weight being 48.1 kg (105.8 lbs) (Figure 5). Conversely, female volunteers met their new screening weight, on average, by -7.4 ± 4.9 kg (-16.3 ± 10.8 lbs), with the most weight under a screening weight being -24.4 kg (-53.6 lbs). Only 1.4% (n=17) of the females had weights that equaled their new screening weight. The proportion of female volunteers meeting their new screening weight was greatest for volunteers in the 17 – 20 year old age group (χ^2=17.331, p=0.001, Table 16).

Table 15. Characteristics of volunteers changing compliance status with proposed changes to AR 600-9.

	Males[1]		Females	
	Changed to:		Changed to:	
	Compliant	Noncompliant	Compliant[1]	Noncompliant[2]
n	1	11	73	76
Age (years)	20	32.0 ± 3.8	24.1 ± 5.1	29.9 ± 8.0
Height (cm)	163.2	180.2 ± 9.3	161.6 ± 6.0	164.3 ± 5.6
Weight (kg)	76.7	99.9 ± 11.1	67.8 ± 6.9	75.0 ± 7.6
BMI (kg/m^2)	28.8	30.7 ± 1.0	25.9 ± 2.1	27.7 ± 1.8
Δ STW (kg, current)[3]	8.7	11.4 ± 3.4	6.1 ± 4.9	10.2 ± 4.9
Δ STW (kg, proposed)[3]			1.4 ± 5.2	6.0 ± 4.9
Neck circumference (cm)	40.6	41.2 ± 2.0	32.0 ± 1.3	34.3 ± 1.8
Forearm circumference (cm)			23.6 ± 1.5	25.5 ± 1.7
Wrist circumference (cm)			14.7 ± 0.9	15.6 ± 1.0
Abdomen circumference (cm)	89.3	99.9 ± 4.4	75.6 ± 5.5	85.5 ± 6.4
Hip circumference (cm)			99.2 ± 4.9	104.9 ± 5.3
%BF (USA)	20.8	24.0 ± 0.8	33.9 ± 2.6	32.1 ± 1.9
%BF (DoD)	20.4	24.4 ± 0.9	31.0 ± 3.0	36.6 ± 3.5
Δ %BF from standard (USA)[4]	0.8	0.4 ± 0.1	2.1 ± 2.1	-1.1 ± 1.2
Δ %BF from standard (DoD)[4]	0.4	0.8 ± 0.2	-0.9 ± 3.0	3.4 ± 3.0

STW, screening table weight (weight-for-height); %BF (USA), percent body fat U.S. Army equation; %BF (DoD), percent body fat DoD equation.

[1]Changed from noncompliant to compliant and from compliant to noncompliant with proposed changes to AR 600-9 (adopt DoD body fat equation).

[2]Changed from noncompliant to compliant and from compliant to noncompliant with proposed changes to AR 600-9 (adjust screening weight and adopt DoD body fat equation). Represents only female volunteers that exceeded their screening weight and body fat standard (excludes 29 females who met their new screening weight and exceeded their body fat standard and are considered noncompliant).

[3]Difference between body weight and screening weight-for-height (body weight – screening weight)

[4]Difference between measured body fat and body fat standard (body fat – body fat standard)

Figure 5. Proximity of female volunteers to their proposed AR 600-9 screening weight. Each bar represents 2.5 kg.

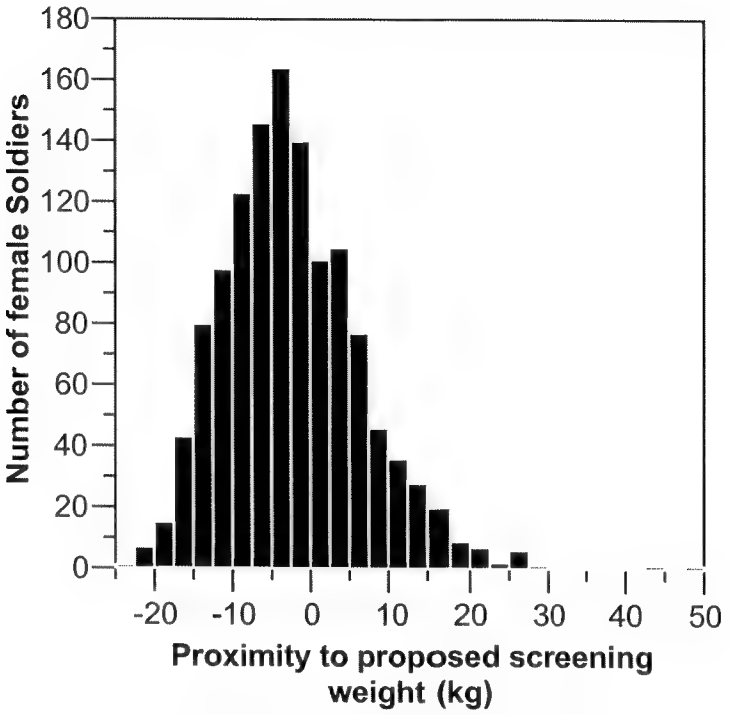


Table 16. Female volunteer's compliance with proposed screening weights by AR 600-9 age groups.

	AR 600-9 age groups [1]				
	17-20	21-27	28-39	≥40	Total
Meet	171 (74.7%)	384 (66.9%)	240 (60.3%)	30 (53.6%)	825
Exceed	58 (25.3%)	190 (33.1%)	158 (39.7%)	26 (46.4%)	432
Total	229	574	398	56	1257

Percent of column totals in parentheses.
[1]Significant differences in compliance status across AR 600-9 age groups, χ^2=17.331, p=0.001.

Adopting the DoD body fat equations reduced the proportion of males, from 88.5% to 87.9%, and females, from 76.7% to 73.3%, that met their body fat standard (Table 12). The range of measured percent body fat using the DoD equation was wide for both groups: -1.5 to 33.3 percent body fat for males and from 5.8 to 51.0 percent body fat for females (Figure 6). Fifteen male (1.0%) and 13 female volunteers (1.0%) had percent body fat measurements below the essential body fat level of 3.0% and 12.0 percent body fat, respectively (16). Essential body fat is fat stored in bone marrow, organs, nervous tissue, and sex-specific depots in breasts, pelvis, buttock, and thighs for females. Two male volunteers had negative percent body fat measurements (-0.9 and -1.5 percent body fat). Because their compliance with AR 600-9 was correctly documented, they are included in the data analysis but excluded from Figure 6. On average, overfat male and female volunteers exceeded their body fat standard by 2.7 ±

1.8 percent body fat and by 5.0 ± 3.5 percent body fat, respectively (Figure 7). Male and female volunteers exceeded their body fat standard, on average, by 11.3% and 17.0 percent body fat, respectively. Male and female volunteers that met their body fat standard did so by -6.9 ± 4.8% and by -7.0 ± 5.1 percent body fat, with the largest difference being -3.5 percent body fat and -28.2 percent body fat, respectively (Figure 7). Differences in compliance with the proposed AR 600-9 across AR 600-9 age groups were significant in males (χ^2=14.403, p=0.002) but not females (χ^2=4.721, p=not significant, Table 17). Male volunteers ages 17 – 20 and ≥40 years old were more likely to be compliant with their body fat standard.

Figure 6. Distribution of volunteers by percent body fat (DoD equations). Two volunteers with <0% body fat are not included. Each bar represents 2% body fat.

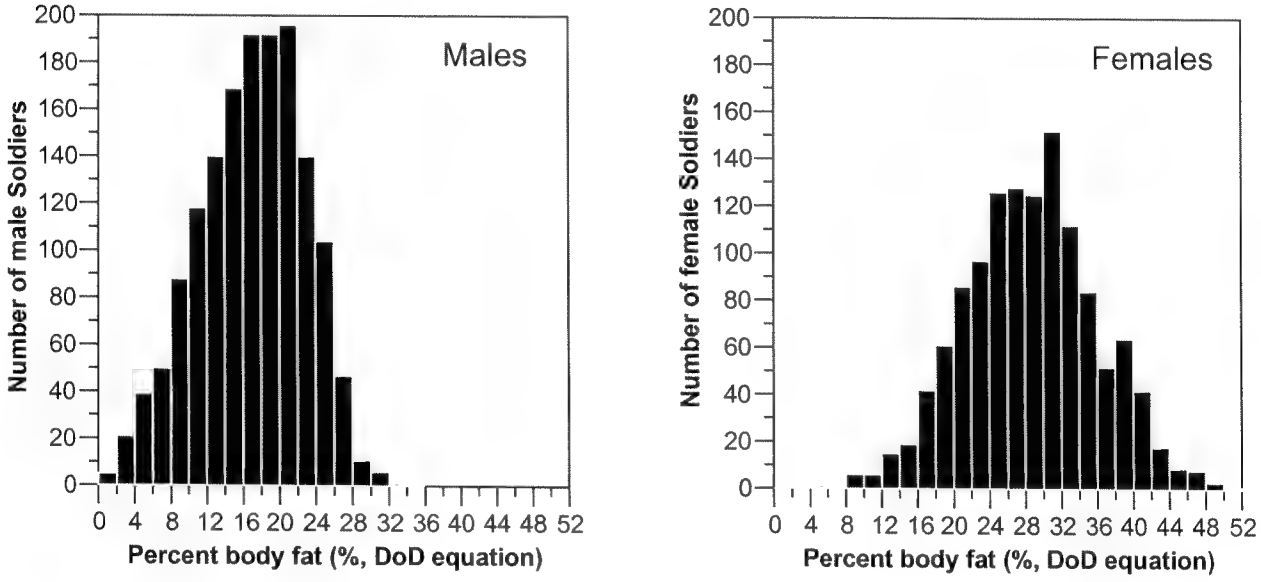


Figure 7. Proximity of volunteers to their body fat standard (DoD body fat equations). Each bar represents 2% body fat.

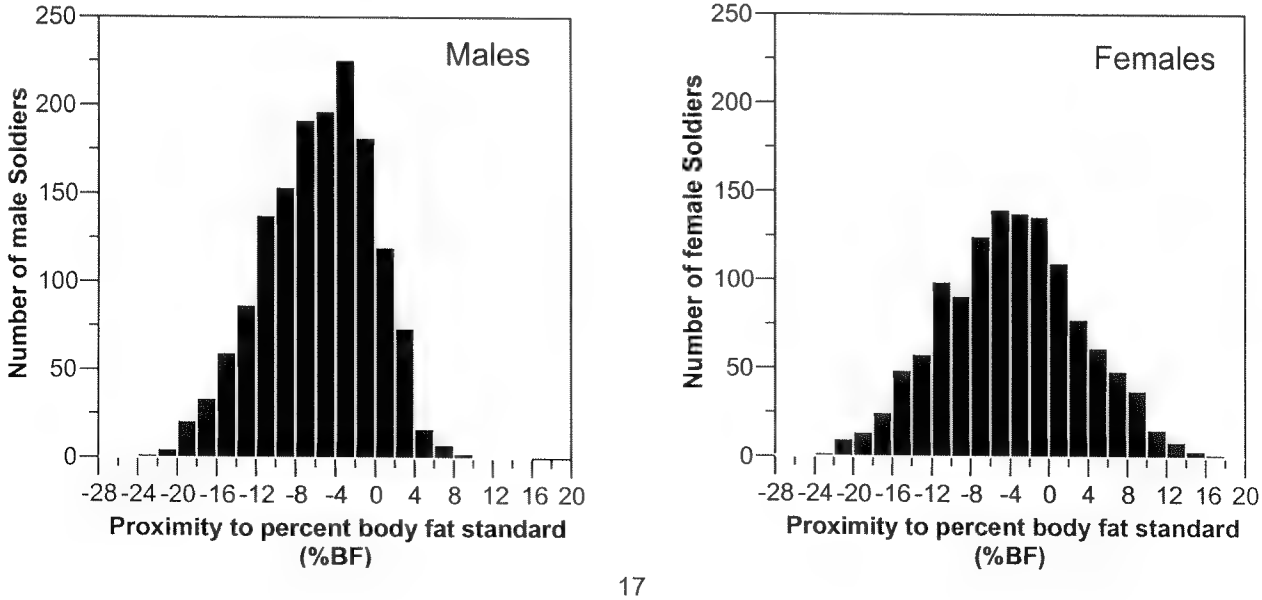


Table 17. Compliance with percent body fat standards by age group (DoD equations).

	Males[1]					Females[2]				
	AR 600-9 age groups					AR 600-9 age groups				
	17-20	21-27	28-39	≥40	Total	17-20	21-27	28-39	≥40	Total
Meet	232 (93.2)	548 (85.6)	456 (86.9)	101 (94.4)	1337	162 (70.7)	420 (73.2)	303 (76.1)	36 (64.3)	921
Exceed	17 (6.8)	92 (14.4)	69 (13.1)	6 (5.6)	184	67 (29.3)	154 (26.8)	95 (23.9)	20 (35.7)	336
Total	249	640	525	107	1521	229	574	398	56	1257

Percent of column totals are given in parentheses.
[1]Significant differences in compliance status across AR 600-9 age groups, χ^2=14.403, *p=0.*002.
[2]Differences in compliance status across AR 600-9 age groups are nonsignificant, χ^2=4.721, *p*=not significant.

The relationship and agreement between the two body fat equations differed by gender. The association between the body fat equations for males was r = 1.0, *p=0.*0005, with minimal scatter about the line of regression (Figure 8). In contrast, the association was not as high for females (r=0.82, *p=0.*0005, Figure 8), and there was more scatter about the line of regression. The bias between the two equations varied with level of body fat, and there was a small but significant positive slope for males (0.12, p < 0.0001) and females (0.41, p < 0.0001, Figure 9); regression slopes were significantly different between the males and females (F=362.983, *p=0.*0005). That is, with increasing body fat, the DoD equations measured more body fat than the Army equations, and with decreasing body fat, the DoD equations measured less body fat than the Army equations. The limits of agreement (mean difference ± 2s) are narrower for the males compared to the females (Figure 9). The equation to predict the limits of agreement (95% limits of agreement) in predicting the bias between the two equations for males is ⁻2.531 + (0.117*average percent body fat) ± (0.225) and for females is ⁻12.894 + (0.417*average percent body fat) ± (6.854). Characteristics of female volunteers with extreme differences in percent body fat between the DoD and Army equations are at Table 18. Inclusion of the abdomen I (waist) measurement is underscored by the dramatic increases in percent body fat noted in observations 1 and 2.

Figure 8. Relationship between the Army and DoD body fat equations. The line of identity (x=y) is drawn as the dark reference line.

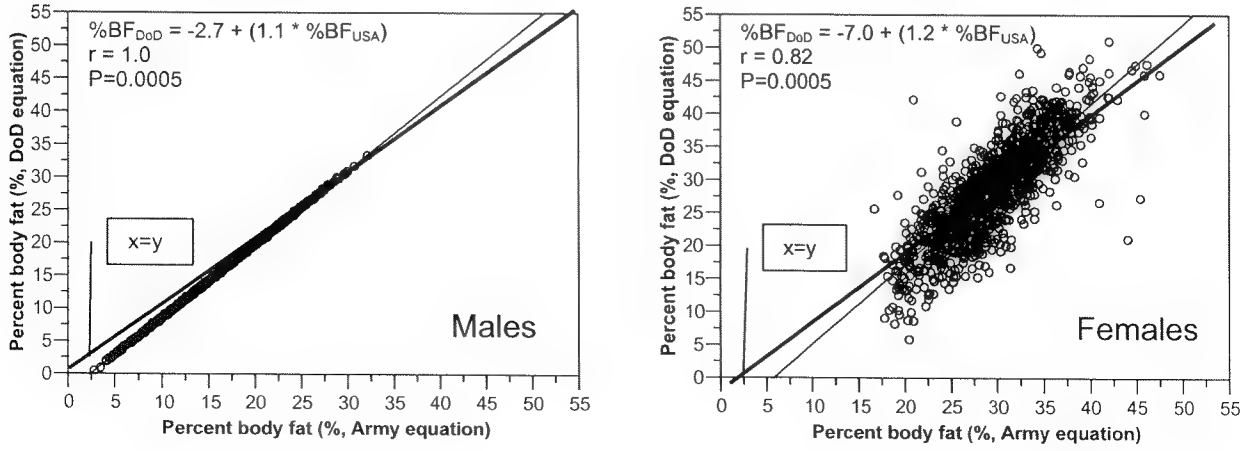


Figure 9. Regression based limits of agreement in measuring percent body fat by the Army and DoD equations.

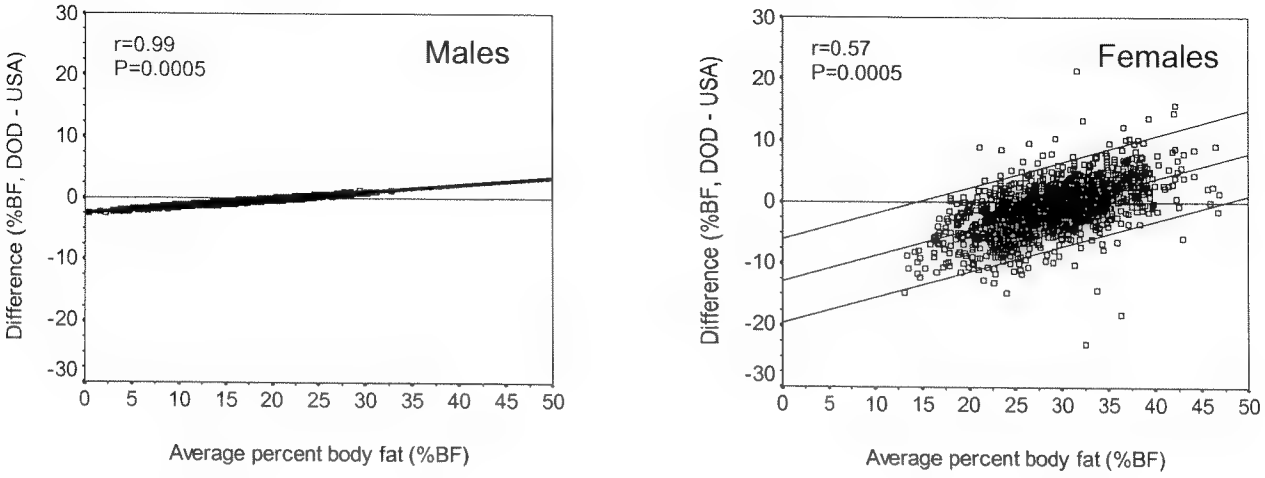


Table 18. Characteristics of female volunteers with extreme differences between the Army and DoD body fat equations.

	BMI	Army	DoD	Neck	Forearm	Wrist	Waist[1]	Hip[1]
	(wt/ht^2)	(%BF)	(%BF)	(cm)	(cm)	(cm)	(cm)	(cm)
1	22.3	20.9	42.2	34.6	27.9	14.9	93.4	110.5
2	34.8	34.3	50.0	34.5	32.4	17.8	108.6	121.3
3	22.6	41.0	26.6	30.5	14.6	13.3	66.0	92.7
4	35.2	45.0	27.3	31.8	24.1	14.6	74.3	90.2
5	31.2	44.0	21.1	29.9	22.2	14.0	64.1	87.0

BMI, body mass index (kg/m^2); DoD, Department of Defense body fat equation; %BF, percent body fat.
[1]To convert cm to inches divide by 2.54.

IDENTIFICATION OF UNHEALTHY SOLDIERS

Waist circumferences of 102 cm (40 inches) and 89 cm (35 inches) for men and women, respectively, are indicative of increased health risk (21). There were 156 volunteers (61 males and 95 females) that exceeded these waist circumference cutoffs (Table 19). Of volunteers with a high waist circumference, 90.2% (55 / 61) of the males and 92.6% (88 / 95) of the females exceeded their screening weight and body fat standard, thereby being noncompliant with AR 600-9 (Tables E1 and E2, respectively). These are improvements over the current program where 86.9% (53/61) of the males and 76.8% (73/95) of the females were noncompliant with AR 600-9. That is, switching to the new DoD body fat equations identified 3.3% (n=2) more males and 15.8% (n=15) more females with a high waist circumference than the current Army equations (Tables E1 and E2, respectively). Few male, 9.8% (n=6), and female, 3.2% (n=3), volunteers with high waist circumferences were compliant with their current and proposed AR 600-9 weight-for-height and percent body fat standard (Table 19). On average, male volunteers with high waist circumferences (>102 cm) exceeded their screening weight by 16.2±7.3 kg and their body fat standard by 2.7±2.2 and 3.4±2.3 percent body fat, using the Army or DoD body fat equation, respectively (p=0.0005 compared to

volunteers with a normal waist circumference, Table 20). Similarly, female volunteers with high waist circumferences (>89 cm) exceeded their current and proposed screening weights by 17.0±8.9 and 12.7±8.8 kg, respectively. They also exceeded their body fat standards by 2.7±4.6% and 8.2±4.2 percent body fat, measured with the Army and DoD body fat equations, respectively (Table 20).

Table 19. Compliance with current and proposed AR 600-9 in volunteers with high waist circumferences[1].

	Males			**Females**		
	Current AR 600-9			Current AR 600-9		
Proposed	Meet	Exceed	Total	Meet	Exceed	Total
Meet	6 (9.8%)	0	6	3 (3.2%)	0	3
Exceed	2 (3.3%)	53 (86.9%)	55	19 (20.0%)	73 (76.8%)	92
Total	8	53	61	22	73	95

Percent of total sample are given in parentheses.
[1]Unable to report McNeamar χ^2 because 1 or more cells have expected counts less than 5.

Table 20. Characteristics of volunteers with high and normal waist circumferences[1].

	Males		Females	
	Waist ≤40"	Waist > 40"	Waist ≤35"	Waist > 35"
n	1460	61	1162	95
Age (years)	27.3 ± 7.1	31.8 ± 7.2[2]	26.3 ± 6.4	29.2 ± 8.5[3]
Height (cm)	176.3 ± 6.8	180.9 ± 7.2[2]	163.0 ± 6.1	166.1 ± 6.2[2]
Weight (kg)	80.3 ± 11.3	104.8 ± 8.4[2]	64.1 ± 8.6	83.3 ± 11.0[2]
BMI (kg/m^2)	25.8 ± 3.2	32.1 ± 2.3[2]	24.1 ± 2.9	30.1 ± 3.2[2]
Δ STW (kg, current)[4]	-2.9 1 ± 9.8	16.2 ± 7.3[2]	0.9 ± 7.5	17.0 ± 8.9[2]
Δ STW (kg, proposed)[4]			-3.6 ± 7.6	12.7 ± 8.8[2]
Neck circumference (cm)	38.3 ± 2.1	42.2 ±2.2[2]	32.2 ± 1.7	35.1 ± 2.3[2]
Forearm circumference (cm)			24.0 ± 1.7	26.7 ± 1.9[2]
Wrist circumference (cm)			14.9 ± 1.0	15.8 ± 0.9[2]
Abdomen circumference (cm)	85.4 ± 8.0	105.2 ± 3.0[2]	73.9 ± 6.9	93.8 ± 3.9[2]
Hip circumference (cm)			95.7 ± 7.9	109.2 ± 9.1[2]
%BF (USA)	17.0 ± 5.0	26.3 ±1.9[2]	28.9 ± 4.6	35.8 ± 4.6[2]
%BF (DoD)	16.5 ± 5.6	26.9 ± 2.1[2]	27.6 ± 6.5	41.2 ± 4.2[2]
Δ %BF from standard (USA)[5]	-5.6 ± 4.7	2.7 ± 2.2[2]	-3.5 ± 4.6	2.7 ± 4.6[2]
Δ %BF from standard (DoD)[5]	-6.1 ± 5.2	3.4 ± 2.3[2]	-4.8 ± 6.4	8.2 ± 4.2[2]

STW, screening table weight (weight-for-height); %BF (USA), percent body fat U.S. Army equation; %BF (DoD), percent body fat (DoD equation).
[1]Waist circumferences based on NHLBI guidelines. Significance set at p=0.005 (0.05/11), with Bonferroni correction for multiple comparisons for males and p=0.003 (0.05/15) for females.
[2,3]Greater than group with normal waist circumference, p=0.0005[2], p=0.002[3].
[4]Difference between body weight and screening table weight (body weight – screening table weight).
[5]Difference between measured body fat and body fat standard (body fat – body fat standard).

DISCUSSION

The principal aim of this study was to determine the impact of proposed changes to AR 600-9 i.e., increasing female screening weights and adopting the DoD body fat equations for males and females on apparent compliance of active duty Soldiers with Army body fat standards. Our results indicate that fewer females exceeded their proposed screening weight-for-height, from 54.6% to 34.4%, yet there was no change in the proportion of females exceeding their screening weight and body fat standard (i.e., were noncompliant), from 22.4% to 22.6%. Of the males, 38.1% exceeded their screening weight; approximately 11% of the males exceeded both their screening weight and body fat standard (i.e., were noncompliant) regardless of whether body fat was measured with the Army or DoD equation. Although the prevalence of noncompliance with AR 600-9 remained stable for both the males and females, the status of some volunteers changed from compliant to noncompliant and vice versa when assessed using the current and proposed AR 600-9. Indeed, agreement in compliance status between the current and proposed AR 600-9 was higher in males than females, 99.1% vs. 85.6%, respectively. Taken together, these results suggest that the U.S. Army is holding the line on weight control and that the readiness and health objectives of AR 600-9 will be maintained with proposed changes.

Noncompliance with AR 600-9 (current or proposed) was significantly higher in female than male volunteers. There were 10.5% of the male and 22.4% of the female volunteers that were noncompliant with AR 600-9. This supports noncompliance rates for males, but not for females as previously reported by Leu and Friedl (10.7% and 16.7%, respectively (16). Discrepancies between our results and those of Leu and Friedl are due, in part, to differences in study populations. Indeed, our data were added to those of Leu and Friedl (16) resulting in nearly a 1.5-fold increase of male volunteers and a large 4-fold increase of female volunteers in the database. Female Soldiers were over-sampled to ensure a more robust sample than that reported by Leu and Friedl (16).

That nearly a third of the sample exceeded current AR 600-9 standards supports some but not all reported noncompliance rates. Vogel et al. reported that 20% of male and 28% of female Soldiers exceeded their screening weight and body fat standard (26). Friedl et al. reported in a nonrandom cohort of male and female recruits that 5.8% of male and 8.9% of female Soldiers were on the Army Weight Control Program 6 months after completing Basic Combat Training (11); at the time of the study, female body fat standards were more stringent than current standards by 2 percent body fat. Other reports of noncompliance with AR 600-9 in female Soldiers ranged from 17.9% in Basic Combat Trainees (28) to 9% in active duty female Soldiers (4). Our results likely indicate higher noncompliance rates primarily because this was an "unofficial" weigh-in; Soldiers exceeding yet close to their screening weight lose weight prior to an official weigh-in (18; 24; 25). Nearly 14% of male and 20% of female volunteers were within 10 lbs of their screening weight (8% of males and 11% of females being 5 lbs or less of their screening weight), an amount of weight that can be lost in a short period of time. Thus, we consider our data to represent a reliable assessment of compliance with the current AR 600-9.

Leu and Friedl reported a reduction in the prevalence of noncompliance in female volunteers (from 17% to 12%) with these proposed changes to AR 600-9; males remained at approximately 11% (16). Data from our larger database suggests that there is no change in the prevalence of noncompliance between the current and proposed AR 600-9, with males remaining at nearly 11% and females at approximately 22%. Observed differences in female noncompliance rates may be due to the subsequent recruitment of female volunteers who had, on average, larger waist circumferences, a measurement site in the DoD equation but not in the current Army equation, resulting in a higher average body fat (from 25.0 ± 7.4 to 30.0 ± 6.7 percent body fat). That compliance with the current and proposed AR 600-9 was greater in the youngest male volunteers (i.e., 17 – 20 year old age group) than in young female volunteers supports previous observations by Friedl et al. (11). They reported that in a cohort of young male recruits followed for changes in body weight during and 6 months after Army basic training, weight loss continued, with 5.8% reported to be on the Army Weight Control Program. Conversely, female recruits followed over the same time period gained weight 6 months after basic training.

Increasing female screening weights resulted in 20% more female volunteers meeting their screening weight and, therefore, not required to undergo a body fat measurement. This, in effect, reduces the burden of having to unnecessarily measure the body fat of many female Soldiers. That is, 54.6% (n=686) of the female volunteers (compared to 38.1% [n=579] of the male volunteers) would have had to have their body fat measured because they exceeded their current screening weight. Of those requiring a body fat measurement, 59.0% (n=405) of the females and 72.4% (n=419) of the males met their body fat standard, thereby complying with the current AR 600-9. This indicates a much lower range of screening weights relative to the body fat scale for female Soldiers compared to male Soldiers. The proportion of females required to have a body fat measurement after increasing female screening weights is reduced to 34.4% (n=432, similar to the proportion of males being screened for excess body fat). Therefore, adopting the proposed screening weight will enhance the overall "efficiency" of efforts to enforce AR 600-9, with minimal negative impact on precision of the process to identify overfat Soldiers.

Current Army female screening weights are the lowest across the DoD and are more stringent than the minimum screening weights prescribed in DoDI 1308.3. Indeed, when converted to BMI, current screening weights fall below the normal range, based on national recommendations, BMI < 25.0 kg/m^2 (21). That is, female Soldiers are currently held to screening weights that are set too low. Weight loss is indicated for individuals with a normal body weight if their waist circumference exceeds the cutoffs of 40" and 35" for males and females, respectively, and/or if a comorbid condition is present (21). Only 0.9% (n=5) of the female Soldiers meeting their current screening weights had a waist circumference exceeding 35 inches. The impact of setting low screening weights on the health of female Soldiers is unclear; however, high rates of dieting (27), use of unhealthy weight management practices (24; 25), and patterns of disordered eating (15; 18; 19; 22) have been reported in military populations.

Abdominal fat is positively correlated with waist circumference, and an increased waist circumference allows for identification of Soldiers at risk for developing diseases such as hypertension, type 2 diabetes, high cholesterol, or heart disease (21). Inclusion of abdominal/waist measurements in the DoD equations is considered beneficial because it is a site of fat mobilization during weight loss, storage during weight gain, and a marker of increased disease risk (21). Indeed, identifying more unhealthy volunteers (i.e., with a high waist circumference) as noncompliant with the proposed AR 600-9, from 76.8% to 96.8% for females and from 86.9% to 90.2% for males, better aligns Army weight control program objectives with force health protection goals (20). Health education received by these Soldiers should help not only to reduce body weight but also disease risk. It is anticipated that identification of unhealthy Soldiers with large waist circumferences will also improve the appearance of the force.

The prevalence of overweight varied by gender as 60% of male and 41% of female volunteers had a high BMI compared to 67% and 62% of American males and females, respectively (9). Body mass index may overestimate total body fat in muscular individuals (21) and may not accurately reflect true rates of overweight and obesity (based on body fat) in military populations (1). Therefore, if the prevalence of overweight is adjusted to that indicated by body fat measurements using U.S. Army age-adjusted body fat standards, 12% of male and 24% of female Soldiers would be truly overweight and overfat. This represents a substantial 48% and 17% reduction in the indicated prevalence of overweight status in the military when compared to using BMI alone. This suggests that the use of BMI and body fat are more indicative of the weight status of a Soldier population than BMI alone. However, body fat norms associated with increased health risk, unacceptable performance, and poor military appearance need to be elucidated.

The large sample size and wide ranges of key variables (age, weight, BMI, and percent body fat) suggest that results can be generalized to the U.S. Army active duty population. This study is unique in that all volunteers had a body fat measurement taken, and volunteers did not self-report compliance status with AR 600-9 (i.e., status was determined using measured height, weight, and percent body fat) therefore, providing a truer picture of compliance. This sample represents approximately 0.6% of the Army total active duty population (0.4% of the males and 1.6% of the females on active duty in FY 2003, Army G-1, Office of Army Demographics) indicating that we successfully over-sampled female volunteers when compared to males. We are confident that the results obtained can be generalized to the Army total active duty population.

In summary, these data suggest that proposed changes to AR 600-9 will not affect the proportion of Soldiers on the Army Weight Control Program. Compared to the current Army Weight Control Program, fewer female Soldiers will unnecessarily undergo a body fat measurement. We anticipate that more female than male Soldiers will change their compliance status (from compliant to noncompliant) with implementation of the proposed AR 600-9. However, more Soldiers with an unhealthy large waist circumference will be identified for enrollment in the Army Weight Control Program. Similar research in Army Reserve and National Guard units should be conducted and a

weight loss/weight maintenance program to help our overfat Soldiers meet these standards should be developed.

CONCLUSIONS

Our data suggest that adjusting female screening weights in AR 600-9 and changing to the DoD body fat equations to comply with DoDI 1308.3 will have the following impacts:

- The proportion of female Soldiers exceeding AR 600-9 standards will not change yet the proportion required to have their body fat measured will be reduced.
- Nearly all female Soldiers with a high waist circumference will be identified as exceeding AR 600-9 standards.
- The proportion of male Soldiers needing to have their body fat measured and exceeding AR 600-9 standards will not change.
- Most male Soldiers with a high waist circumference will be identified.

REFERENCES

1. Bathalon, G. P., L. D. Hennessy, W. F. Barko, and H. R. Lieberman. Application of body mass index as a screening tool for adiposity in a middle-aged military population. *Obes Res* 8 (Suppl. 1): 39S, 2000.

2. Bland J. and D. Altman. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* i: 307-310, 1986.

3. Bland J. and D. Altman. Measuring agreement in method comparison studies. *Stat Methods Med Res* 8: 135-160, 1999.

4. Bray, R. M., L. A. Kroutil, S. C. Wheeless, M. E. Marsden, S. L. Bailey, J. A. Fairbank, and T. C. Harford. *1995 Health behavior and health promotion. Department of Defense Survey of Health-Related Behaviors among military personnel.* Research Triangle Park, NC: Research Triangle Institute. Report No. RTI 6019-6, 1995.

5. Department of Defense, Headquarters. *DoD Physical Fitness and Body Fat Programs Procedures.* Washington, D.C. DoDI 1308.3, November 5, 2002.

6. Department of the Army, Headquarters. *The Army Weight Control Program.* Washington, D.C. AR 600-9, June 10, 1987.

7. Department of the Army, Headquarters. *Use of Human Subjects in Research.* Washington, D.C. AR 70-25, January 25, 1990.

8. Department of the Army, Headquarters. *The Army Weight Control Program.* Washington, D.C. AR 600-9, Interim Change No. I01, November 15, 1991.

9. Flegal KM, M.D. Carroll, C. L. Ogden, and C. L. Johnson. Prevalence and trends in obesity among US adults, 1999-2000. *JAMA* 288: 1723-1727, 2002.

10. Friedl K. E. Body composition and military performance: origins of the Army standards. In: *Body Composition and Physical Performance*, edited by B. Marriott and J. Grumstrup-Scott. Washington, D.C.: National Academy Press, 1992, p. 31-55.

11. Friedl, K. E., J. A. Vogel, M. W. Bovee, and B. H. Jones. *Assessment of body weight standards in male and female Army recruits.* Natick, MA: US Army Research Institute of Environmental Medicine. Technical Report T15-90, December 1989.

12. Hodgdon, J. A., and M. B. Beckett. *Prediction of Percent Body Fat for U.S. Navy Men From Body Circumferences and Height.* San Diego, CA: Naval Health Research Center. Report No. 84-11, March 1984.

13. Hodgdon, J. A., and M. B. Beckett. *Prediction of Percent Body Fat for U.S. Navy Women From Body Circumferences and Height.* San Diego, CA: Naval Health Research Center. Report No. 84-29, June 1984.

14. Hodgdon, J. A., and K. E. Friedl. *Development of the DoD Body Composition Estimation Equations.* San Diego, CA: Naval Health Research Center. Report No. 99-2B, September 1999.

15. Lauder, T. D., M. V. Williams, C. S. Campbell, G. D. Davis, and R. A. Sherman. Abnormal eating behaviors in military women. *Mil Med* 31: 1265-1271, 1999.

16. Leu, J. R., and K. E. Friedl. Body fat standards and individual physical readiness in a randomized Army sample: screening weights, methods of fat assessment, and linkage to physical fitness. *Mil Med* 167: 994-1000, 2002.

17. McArdle, W., F. Katch, and V. Katch. *Exercise Physiology: Energy, Nutrition, and Human Performance*. Baltimore, MD: Williams & Wilkins, 1996.

18. McNulty, P. A. Prevalence and contributing factors of eating disorder behaviors in a population of female Navy nurses. *Mil Med* 162: 703-706, 1997.

19. McNulty, P. A. Prevalence and contributing factors of eating disorder behaviors in active duty service women in the Army, Navy, Air Force, and Marines. *Mil Med* 166: 53-58, 2001.

20. Medical Readiness Division, J-4, The Joint Staff. *Force Health Protection Capstone.* [online] Joint Staff Information Network. http://www.dtic.mil/jcs/j4/organization/hssd/hssd.htm. [July 7, 2004].

21. National Heart, Lung and Blood Institute. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.* Washington, DC: National Institutes of Health. NIH Publication No. 98-4083, September 1998.

22. Peterson A. L., G. W. Talcott, W. J. Kelleher, and S. D. Smith. Bulimic weight-loss behaviors in military versus civilian weight-management programs. *Mil Med* 160: 616-620, 1995.

23. Portney L. G., and M. P. Watkins. *Foundations of Clinical Research: Applications to Practice*. Norwalk, CN: Appleton & Lang, 1993.

24. Rose, M. S., R. Moore, E. Mahnke, E. Christensen, and E. W. Askew. *Weight Reduction Techniques Adopted When Weight Standards are Enforced.* Natick, MA: U.S. Army Research Institute of Environmental Medicine. Technical Report T4-93, March 1993.

25. Sweeney, S. S., and R. C. Bonnabeau. Positive and negative health behaviors used to ensure compliance with the U.S. Army's weight control standards by a reserve component unit. *Mil Med* 155: 255-260, 1990.

26. Vogel, J. A., J. W. Kirkpatrick, P. I. Fitzgerald, J. A. Hodgdon, and E. A. Harman. *Derivation of Anthropometry Based Body Fat Equations for the Army's Weight Control Program.* Natick, MA: US Army Research Institute of Environmental Medicine. Technical Report T17-88, 1988.

27. Warber, J., S. McGraw, F. M. Kramer, L. Lesher, W. Johnson, and A. Cline. *The Army Food and Nutrition Survey, 1995 - 97.* Natick, MA: US Army Research Institute of Environmental Medicine. Technical Report T00-06, 1999.

28. Westphal, K. A., K. E. Friedl, M. A. Sharp, N. King, T. R. Kramer, K. L. Reynolds, and L. J. Marchitelli. *Health, performance, and nutritional status of U.S. Army women during basic combat training.* Natick, MA: U.S. Army Research Institute of Environmental Medicine. Technical Report T96-2, 1995.

Appendix A: DoDI 1308.3 Screening Weight-for-Height Range

Table A-1. Screening weight range (lowest and highest) as established in DoDI 1308.3. Lowest and highest screening weights are equivalent to a BMI of 25.0 kg/m^2 and 27.5 kg/m^2, respectively.

Height (inches)	Screening Weights	
	Lowest [1]	Highest[2]
	lbs	
58	119	131
59	124	136
60	128	141
61	132	145
62	136	150
63	141	155
64	145	160
65	150	165
66	155	170
67	159	175
68	164	180
69	169	186
70	174	191
71	179	197
72	184	202
73	189	208
74	194	214
75	200	220
76	205	225
77	210	231
78	216	237
79	221	244
80	227	250

BMI, body mass index

[1]Service screening weights may not be more stringent than shown; equivalent to a BMI of 25.0 kg/m^2.

[2]Service screening weights can not exceed weights shown; equivalent to a BMI of 27.5 kg/m^2.

Appendix B: AR 600-9 Screening Weight-for-Height Tables

Table B-1. AR 600-9 screening weights for male Soldiers[1].

Height	Age Group[2] 17-20	21-27	28-39	≥40
inches		*lbs*		
60	132	136	139	141
61	136	140	144	146
62	141	144	148	150
63	145	149	153	155
64	150	154	158	160
65	155	159	163	165
66	160	163	168	170
67	165	169	174	176
68	170	174	179	181
69	175	179	184	186
70	180	185	189	192
71	185	189	194	197
72	190	195	200	203
73	195	200	205	208
74	201	206	211	214
75	206	212	217	220
76	212	217	223	226
77	218	223	229	232
78	223	229	235	238
79	229	235	241	244
80	234	240	247	250

[1]Screening weights, when converted to BMI, must fall within a BMI range of 25.0 kg/m^2 – 27.5 kg/m^2 as established in DoDI 1308.3.

[2]Approximate BMI targets are ~25.8, ~26.5, ~27.2, and ~27.5 kg/m^2 for the 17-20, 21-27, 28-39, and ≥ 40 years old age groups, respectively. Actual BMI may vary from target because of rounding.

Table B-2. Current and proposed AR 600-9 screening weights for female Soldiers[1].

				(Current)[2]			(Proposed)[3]	
				Age			Age	
Height	17-20	21-27	28-39	≥40	17-20	21-27	28-39	≥40
inches				*lbs*			*lbs*	
58	109	112	115	119	119	121	122	124
59	113	116	119	123	124	125	126	128
60	116	120	123	127	128	129	131	133
61	120	124	127	131	132	134	135	137
62	125	129	132	137	136	138	140	142
63	129	133	137	141	141	143	144	146
64	133	137	141	145	145	147	149	151
65	137	141	145	149	150	152	154	156
66	141	146	150	154	155	156	158	161
67	145	149	154	159	159	161	163	166
68	150	154	159	164	164	166	168	171
69	154	158	163	168	169	171	173	176
70	159	163	168	173	174	176	178	181
71	163	167	172	177	179	181	183	186
72	167	172	177	183	184	186	188	191
73	172	177	182	188	189	191	194	197
74	178	183	189	194	194	197	199	202
75	183	188	194	200	200	202	204	208
76	189	194	200	206	205	207	210	213
77	193	199	205	211	210	213	215	219
78	198	204	210	216	216	218	221	225
79	203	209	215	222	221	224	227	230
80	208	214	220	227	227	230	233	236

[1]Screening weights, when converted to BMI, must fall within a BMI range of 25.0 kg/m^2 – 27.5 kg/m^2 as established in DoDI 1308.3.

[2]Approximate BMI targets are ~22.9, ~23.6, ~24.3, and ~24.9 kg/m^2 for the 17-20, 21-27, 28-39, and ≥ 40 years old age groups, respectively. Actual BMI may vary from target because of rounding.

[2]Proposed approximate BMI targets are ~25.0, ~25.3, ~25.6, and ~26.0 kg/m^2 for the 17-20, 21-27, 28-39, and ≥ 40 years old age groups, respectively. Proposed BMI may vary from target because of rounding.

Appendix C: Volunteer Questionnaire and Data Collection Form

Body Composition / Fitness Survey

Fort Bragg, 2002

Army leadership (G1, Personnel) and the Sergeant Major of the Army have requested this study to determine the body composition of Army Soldiers that meet or exceed their screening table weights. Your participation is important to help guide future policy on weight management. Your answers to 10 questions will be kept confidential. Total time to complete this study is about 10 minutes.

MARKING INSTRUCTIONS

- Use a No. 2 pencil only.
- Do not use ink, ballpoint, or felt tip pens.
- Make solid marks that fill the response completely.
- Erase cleanly any marks you wish to change.
- Make no stray marks on this form.

CORRECT: ● INCORRECT: ⊘ ⊠ ◒ ◔

Below you will find an example of a question from this booklet. Please note the proper way to record your responses.

Example:

What is your age today?

If your answer is 19 years, then you would write the numbers in the boxes and then darken the corresponding circles. Please make sure that you use leading zeros when needed.

Please write in your response in the blank boxes, then fill in the corresponding circles.

years	1	●
	9	●

U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE (USARIEM)
MILITARY NUTRITION DIVISION
NATICK, MA 01760

Body Composition/Fitness Survey, Ft Bragg, 2002

DATE			SEQUENCE
MONTH	DAY	YEAR	Number

DEMOGRAPHICS

1. **What is your age today?** age ____

2. **Gender:**
   - Male
   - Female

3. **Race or ethnic background. Please fill in only one circle:**
   - Caucasian, not of Hispanic origin
   - African American, not of Hispanic origin
   - Hispanic
   - Native American/Alaskan Native
   - Asian/Pacific Islander
   - Other_____

4. **What is your primary MOS?**

Description:_____

Do not write in this box

othrace

6. **What is your rank?**

E
O
WO

7. **Are you currently on the weight control program?**
   - Yes
   - No

8. **Have you ever been on the weight control program?**
   - Yes
   - No

9. **Do you have a profile for the APFT?**
   - Yes
   - No

FEMALES ONLY

10. **Have you ever been pregnant?**
    - Yes →
    - No, If NO stop

11. **Are you pregnant now?**
    - Yes
    - No

12. **Have you given birth in the past year?**
    - Yes
    - No

Body Composition/Fitness Survey, Ft Bragg, 2002
For study staff only - do not write in this section.

Height in inches? (without shoes/boots) inches ☐☐ 1/4 1/2 3/4

Weight in pounds? (without clothing) pounds ☐☐☐

Neck - 1	1/4 1/2 3/4	Neck - 2	1/4 1/2 3/4	Neck - 3	1/4 1/2 3/4
Abdomen - 1	1/4 1/2 3/4	Abdomen - 2	1/4 1/2 3/4	Abdomen - 3	1/4 1/2 3/4
Hips - 1	1/4 1/2 3/4	Hips - 2	1/4 1/2 3/4	Hips - 3	1/4 1/2 3/4
Wrist - 1	1/4 1/2 3/4	Wrist - 2	1/4 1/2 3/4	Wrist - 3	1/4 1/2 3/4
Forearm - 1	1/4 1/2 3/4	Forearm - 2	1/4 1/2 3/4	Forearm - 3	1/4 1/2 3/4

Please write your response in the blank boxes, then fill in the corresponding circles. Use leading zeros when needed.

APFT Score	pushup	situp	minutes/seconds
☐	☐	☐	☐ / ☐

Appendix D: Compliance with Current and Proposed AR 600-9

Table D-1. Compliance with current and proposed AR 600-9 in male volunteers.

	Current AR 600-9				
Proposed AR 600-9	Meet STW meet %BF	Meet STW exceed %BF	Exceed STW meet %BF	Exceed STW exceed %BF	Total Proposed AR 600-9
Meet STW Meet %BF	927	1			928 (61.0%)
Meet STW exceed %BF		14			14 (0.9%)
Exceed STW meet %BF			408	1	409 (26.9%)
Exceed STW exceed %BF			11	159	170 (11.2%)
Total current AR 600-9	927 (60.9%)	15 (1.0%)	419 (27.5%)	160 (10.5%)	1521

STW, screening table weight; %BF, percent body fat (standard). Shaded cells indicate agreement in weight status between the current and proposed AR 600-9.

Table D-2. Compliance with current and proposed AR 600-9 in female volunteers.

	Current AR 600-9				
Proposed AR 600-9	Meet STW meet %BF	Meet STW exceed %BF	Exceed STW meet %BF	Exceed STW exceed %BF	Total Proposed AR 600-9
Meet STW meet %BF	552	11	187	23	773 (61.5%)
Meet STW exceed %BF	7	1	29	15	52 (4.1%)
Exceed STW meet %BF			113	35	148 (11.8%)
Exceed STW exceed %BF			76	208	284 (22.6%)
Total current AR 600-9	559 (44.5%)	12 (1.0%)	405 (32.2%)	281 (22.4%)	1257

STW, screening table weight; %BF, percent body fat (standard). Shaded cells indicate agreement in weight status between the current and proposed AR 600-9.

Appendix E: Compliance of Large-Waisted Volunteers with Current and Proposed AR 600-9

Table E-1. Compliance with current and proposed AR 600-9 in 61 males with a waist circumference > 102 cm (> 40 inches).

	Current AR 600-9				
Proposed AR 600-9	Meet STW meet %BF	Meet STW exceed %BF	Exceed STW meet %BF	Exceed STW exceed %BF	Total Proposed AR 600-9
Meet STW meet %BF					
Meet STW exceed %BF					
Exceed STW meet %BF			6		6 (9.8%)
Exceed STW exceed %BF			2	53	55 (90.2%)
Total current AR 600-9			8 (13.1%)	53 (86.9%)	61

STW, screening table weight; %BF, percent body fat (standard). Shaded cells indicate agreement in weight status between the current and proposed AR 600-9.

Table E-2. Compliance with current and proposed AR 600-9 in 95 females with a waist circumference > 89 cm (> 35 inches).

	Current				
Proposed	Meet STW meet %BF	Meet STW exceed %BF	Exceed STW meet %BF	Exceed STW exceed %BF	Total Proposed
Meet STW meet %BF			1		1 (1.1%)
Meet STW exceed %BF	2		1	1	4 (4.2%)
Exceed STW meet %BF			2		2 (2.1%)
Exceed STW exceed %BF			16	72	88 (92.6%)
Total current	2 (2%)		20 (21.1%)	73 (76.8%)	95

STW, screening table weight; %BF, percent body fat (standard). Shaded cells indicate agreement in weight status between the current and proposed AR 600-9.

Table E-3. Characteristics of large-waisted volunteers who changed their status from compliant to noncompliant with changes to AR 600-9.

	Males	Females
n	2	16
Age (years)	33.0 ± 5.7	34.4 ± 10.0
Height (cm)	192.7 ± 10.3	167.5 ± 6.1
Weight (kg)	115.2 ± 8.8	81.9 ± 9.6
BMI (kg/m^2)	31.0 ± 0.9	29.2 ± 2.3
Δ STW (kg, current)[4]	14.0 ± 2.9	13.6 ± 7.2
Δ STW (kg, proposed)[4]		9.7 ± 7.0
Neck (cm)	43.5 ± 0.4	35.9 ± 1.8
Forearm (cm)		27.6 ± 2.3
Wrist (cm)		16.2 ± 1.1
Abdomen (cm)	106.4 ± 3.1	94.8 ± 5.9
Hip (cm)		109.7 ± 7.7
%BF (USA)	24.3 ± 0.2	32.6 ± 1.8
%BF (DoD)	24.9 ± 0.03	41.2 ± 4.4
Δ %BF (USA)[4]	0.3 ± 0.2	-1.7 ± 1.3
Δ %BF (DoD)[4]	0.9 ± 0.03	6.9 ± 4.4

BMI, body mass index; STW, screening table weight; %BF, percent body fat; USA, Army body fat equations; DoD, Department of Defense body fat equations.